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## THE ROLE OF DNA EVIDENCE IN ENSURING FAIRNESS AND ACCURACY IN THE JUDICIAL PROCESS

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### **Abstract**

The integration of DNA evidence into the judicial process has become a vital factor in promoting fairness and precision throughout global criminal justice systems. This study examines the diverse functions of DNA technology, charting its progression from conventional blood typing techniques to advanced technologies like Polymerase Chain Reaction (PCR) and Short Tandem Repeats (STR) analysis. The importance of DNA evidence is twofold: it may identify offenders and exonerate the innocent, thus upholding the core principles of justice.

The study commences with an analysis of the fundamental attributes of DNA, encompassing its structure, origins, and the paramount significance of preserving the integrity of evidence materials. Comprehending these fundamental elements is essential for recognizing the efficient application of DNA in legal contexts. The paper examines pertinent statutes and constitutional provisions in India that regulate the admissibility and utilization of DNA evidence, highlighting the intricate balance between efficient law enforcement and the safeguarding of individual rights. Fundamental legal structures, such the Criminal Procedure Code and the Indian Evidence Act, establish a foundation for examining the incorporation of DNA evidence into judicial processes.

Significant judicial cases demonstrate how courts have addressed the reliability and admissibility of DNA evidence. These instances demonstrate a growing recognition of DNA's significance in determining guilt or innocence, while also acknowledging obstacles such as contamination, procedural inaccuracies, and ethical issues related to privacy. This dichotomy underscores the necessity for stringent standards in evidence collection and interpretation to avert miscarriages of justice.

This study identifies substantial deficiencies in existing methods and recommends legislative

amendments to improve the reliability and integrity of DNA evidence. This project aims to enhance public trust in the role of forensic science in legal procedures by promoting rigorous protocols for evidence handling, storage, and analysis. This work ultimately contributes to the discourse on the importance of scientific evidence in attaining equitable results in criminal trials. It contends that although DNA evidence is a potent instrument for justice, it must be utilized judiciously and responsibly to maintain principles of fairness, accuracy, and respect for individual rights in the legal process.

**Keywords:** DNA Evidence, Criminal Justice, Forensic Science, Judicial Process, Legislative Reforms.

## **Introduction**

Currently, criminal activities are executed with greater sophistication and organization. Furthermore, novel forms of criminal activity perpetually emerging. are To effectively manage such situations, investigating authorities depend on systematic and scientific investigative processes. DNA technology has emerged as a significant investigative tool following the ground-breaking research conducted by Professor Sir Alec Jeffreys at Leicester University, London, in 1985. Prior to the 1980s, DNA was utilized only for scientific study and purposes. It has now assumed a significant position in forensic science. Forensic science, as a scientific methodology operating within the confines of the legal system, provides rules for civil and criminal investigations while delivering precise information regarding all aspects of criminal identification. The advent of DNA technology elevates forensic science from a passive role to an active participant in the administration of justice.

DNA, or Deoxyribonucleic acid, serves as the genetic blueprint for every human being. The chemical composition of DNA within the cells of each human is distinctive. This is the exclusive criterion for distinguishing one individual from another, with the exception of genetically identical twins. The advancement of this technology enables the precise identification of criminals when biological evidence is retrieved from the crime scene. Simultaneously, it can also serve to exonerate individuals wrongfully accused or convicted of crimes. Consequently, DNA technology is regarded as the most effective means of uncovering the truth. Former Justice *Markendey Katj*u stated in his book, *Law in the Scientific Era*<sup>1</sup>:

The utilization of DNA technology guarantees equity within the criminal justice system. Indeed, the use of DNA technology has significantly contributed to criminal investigations. The applications include:

- (a) Identifying offenders in sexual assault cases,
- (b) Identifying offenders in homicide cases,
- (c) Establishing paternity and maternity of a child,
- (d) Identifying disfigured remains,
- (e) General identification of criminals, and
- (f) Immigration purposes.

(a) Identification of offenders in sexual assault cases: DNA evidence is highly beneficial in such instances. Following the rape occurrence, the biological evidence obtained from the crime scene or samples gathered from the victim are analyzed in comparison to samples taken from the perpetrator using DNA technology. The comparative results may assist in determining if the suspect perpetrated the rape. If the suspect has perpetrated rape, it can be determined with better precision.

(*b*) *Identification of perpetrators in homicide cases:* In homicide cases, DNA technology is employed to ascertain the actual offender responsible for the crime. The perpetrator of a homicide may frequently leave biological evidence at the crime scene, such as bloodstains, hair follicles, and bodily fluids. Frequently, bloodstained items such as weapons, swords, and the victim's bloodied clothing may be confiscated from the accused's possession. All these material evidences are pertinent for DNA analysis, which demonstrates the presence of the accused at the crime scene.

(c) Determination of a child's paternity and maternity: Typically, all individuals inherit their DNA profile from their biological progenitors. If the paternity or maternity of a child is contested, a simple comparison of DNA from the father or mother with that of the kid can provide a definitive result with enhanced accuracy. Occasionally, a female infant is substituted

<sup>&</sup>lt;sup>1</sup> Borrowed from Jothirmoy Adikari, DNA Technology in the administration of Justice, Lexis Nexis Butterworths, 2007, P.4

for a male infant in hospitals. In this scenario, a DNA test resolves the issue. The biological parents of the infant can be determined by a DNA test. The identification of a missing or deceased individual can also be accomplished through DNA technology. In India, DNA identification was utilized to ascertain the parentage of children separated from their parents by the tsunami in December 2004.

(*d*) *Identification of mangled remains:* In India, DNA technology was employed to identify the disfigured remains of the victim and the perpetrator who perished in the Rajiv Gandhi assassination case in 1992. It was utilized to identify remains retrieved from mass graves in Gujarat following the Hindu-Muslim riots in 2002. It was also utilized to identify the deceased who perished in the twin tower attacks in the United States in 2001.

(e) General identification of offenders: Occasionally, law enforcement may apprehend multiple individuals based on the suspicion that one among them has perpetrated the offense. On that occasion, biological evidence collected by the authorities at the crime scene or from the victim can be analyzed using DNA technology to identify the actual perpetrator. DNA technology serves not only to identify the true perpetrator but also to exonerate the innocent suspect if they are not involved in the crime.

(*f*) *Immigration purposes:* DNA testing is frequently employed in family-based immigration cases where a United States resident or citizen seeks to sponsor a relative for entry into the United States. In such instances, the sponsor and their relatives must establish their biological connection through DNA testing (paternity test, maternity test, and familial relationship test). Three DNA testing guarantees the identification and exclusion of fraudulent overseas applicants from entering the country. Most developed nations utilize DNA testing to facilitate the immigration process.

Consequently, DNA technology is highly beneficial within the criminal justice system and is being utilized efficiently worldwide. In criminal investigations, DNA is mostly utilized to associate the perpetrator with the offense. Furthermore, DNA is regarded as a formidable tool in criminal investigations because to its neutrality, scientific precision, infallibility, and impartial nature.

## **DNA - DEFINITION**

Deoxyribonucleic Acid<sup>2</sup>, often known as DNA, constitutes the genetic material of all living organisms. It is sometimes referred to as the 'building blocks of inheritance'. The human body has many cells, each containing a complete pair of chromosomes. Each cell contains several components, such as ribosomes and Golgi bodies.<sup>3</sup>

Genes are responsible for protein synthesis in each cell<sup>4</sup>, comprising two primary processes: transcription and translation. Gene expression refers to the method by which genetic information is utilized. The genetic data of humans is predominantly contained within DNA. During transcription, the information encoded in a gene's DNA is conveyed to a comparable molecule known as RNA (ribonucleic acid) within the cell nucleus. RNA and DNA consist of chains of nucleotide bases; however, they possess distinct chemical components.

## **IMPORTANCE OF DNA EVIDENCE**

DNA serves as a viable method since each individual's DNA is distinct, with the exception of identical twins.

- i. DNA remains unchanged throughout an individual's lifetime.
- ii. It remains constant with age.
- Regardless of the tissue from which DNA is extracted—be it brain, hair, semen, blood, bone, sputum, urine, skin, kidney, or any other type—all yield an identical DNA fingerprinting pattern for an individual.
- iv. The DNA content of an individual remains consistent throughout cells, with the exception of gametes (egg and sperm cells). These cells contain half the complement of DNA found in other somatic cells.
- v. DNA is a stable macromolecule. It can be heated, boiled, and denatured. Under suitable conditions, such as buffer and temperature, the strand reassembles into a double helix. It is so stable that it has been extracted from the remnants of bones thousands of years old and even from fossils several million years old. The primary benefit of this cutting-edge technique is its capacity to examine extremely small and environmentally compromised samples, subsequently determining their identity with a high level of

<sup>3</sup> Jothirmoy Adikari, DNA Technology in the Administration of Justice, Lexis Nexis Butterworths, 2007, p. 21.

<sup>&</sup>lt;sup>2</sup> Modi's Medical Jurisprudence and Toxicology, 23rd Edition, Lexis Nexis Butterworths, p. 337

<sup>&</sup>lt;sup>4</sup> Jothirmoy Adikari, DNA Technology in the Administration of Justice, Lexis Nexis Butterworths, 2007, p. 23.

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precision. DNA exhibits significant resistance to degradation induced by environmental factors such as temperature, humidity, and the passage of time, which facilitate the proliferation of microorganisms.

- vi. DNA evidence can resolve especially challenging cases if all other investigation methods, like as interrogation or hostile witnesses, have proven ineffective. The sample obtained from the crime scene will assist in resolving this issue if the suspect had perpetrated the crime. The sample retrieved from the murder scene, assuming it belongs to the culprit, will undoubtedly match his sample. If the sample obtained at the crime scene differs from that of the suspect, it will not correspond with his sample. The DNA evidence serves to either exonerate or implicate the individual.
- vii. In a crime scene, DNA evidence offers a lead to investigative officers in the absence of witnesses. No individual is an impeccable offender. Indeed, offenders may leave traces for identifying purposes. Numerous pieces of evidence are imperceptible to the average individual. This may serve as a crucial element for the forensic analyst. For instance, the spit on the liquor bottle, skin cells collected from the glass he utilized, saliva swabbed from the bite mark, and saliva on cigarette butts can be analyzed in comparison to the suspect's blood sample. It can readily associate the offender with a crime scene.
- viii. The DNA evidence diminishes the incidence of erroneous arrests. Furthermore, it offers a means to identify the true perpetrator.
- ix. A minimal quantity of biological sample suffices for DNA analysis.

The investigative apparatus depends on this DNA evidence for the identification of criminals due to its uniqueness. The United States Department of Justice noted the elimination samples.

### **CRIMINAL IDENTIFICATION**

The primary purpose of DNA fingerprinting in criminal identification is to identify the variances among DNA samples obtained from distinct individuals, which involves comparing materials from a crime scene or samples collected from a victim's body with those of suspects to ascertain the true perpetrator or to exonerate a suspect if their DNA does not correspond. In

criminal investigations, the officers initially examine the scene. Subsequently, they gather the evidentiary materials from the crime scene. Items or biological specimens such as blood-stained weapons, garments, semen residues, and bodily tissues are associated with the crime. These samples are compared with those of the suspect for identification purposes. DNA technology is utilized in instances such as rape, murder, property crimes, accident cases, and bomb blasts.

These represent the advancements in DNA technology and its analysis. Upon the introduction of new scientific technology in the legal domain, whether in criminal or civil cases, it is imperative to first assess the constitutional legality of adopting such technology. The subsequent chapter examines the constitutional legitimacy of conducting DNA tests and other laws, particularly in relation to criminal detection.

## THE RELEVANT STATUTES ON DNA

This chapter delineates the pertinent statutes concerning DNA technology within the Criminal Justice System of India. The pertinent statutes include the Criminal Procedure Code, 1973 (Sections 53, 54, 53A, 164A, 173(8), and 293(2) & (4)), the Indian Evidence Act, 1872 (Sections 45 and 112), and the Prevention of Terrorism Act, 2002 (Section 27(1)). This chapter delineates the pertinent Articles of constitutional law (Article 51A (h) & (j), Article 246 (entry 65 and entry 66)) and thoroughly examines the constitutional legitimacy of DNA technology in relation to Articles 21 and 20(3) of the Indian Constitution.

### **The Criminal Procedure Code, 1973**

Although India lacks formal DNA legislation, Sections 53 and 54153 of the Code of Criminal Procedure, 1973 implicitly permitted DNA testing prior to the 2005 revision, and these provisions were often utilized in resolving intricate criminal cases. Section 53 pertains to the assessment of the accused individual by a licensed medical practitioner upon the request of a police officer, provided there are justifiable grounds to suspect that such an examination will yield evidence regarding the perpetration of an infraction. Section 54 of the Criminal Procedure Code, 1973 stipulates the examination of an arrested individual by a registered medical practitioner upon the request of the arrested individual.

Section 53 of the Criminal Procedure Code was revised in 2005 by the Code of Criminal Procedure (Amendment) Act, 2005.One hundred fifty-four The revision to the Code of

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Criminal Procedure Act, 2005 has introduced two new sections, Section 53A and Section 164A, which empower the investigating officer to obtain DNA samples from both the accused of rape and the victim, facilitated by a qualified medical practitioner.155 While Section 53 pertains solely to the examination of the accused by a medical practitioner at the behest of a police officer, the court possesses broader authority to ensure justice in criminal cases by directing the police officer to obtain blood samples from the accused and perform DNA testing. Upon concluding the inquiry, the charge sheet is submitted to the Magistrate. When necessary, the police may submit a request to the court for additional investigation pursuant to Section 173(8) of the Criminal Procedure Code, 1973.156 The court may subsequently mandate additional inquiry pursuant to Section 173(8) of the Criminal Procedure Code, 1973(8) of the Criminal Procedure Code, 1973.

Section 53 of the Criminal Procedure Code, 1973 may be applied even if the accused has been granted bail following an arrest under Section 438 of the same code. The Magistrate may authorize the collection of a blood sample to do a DNA test at the request of a police officer for the purpose of an effective investigation. This has been explicitly elucidated below by the superior courts. They are as follows:

### **Indian Evidence Act, 1872**

In addition to the stipulations of the Criminal Procedure Code, 1973, Section 45 of the Indian Evidence Act, 1872 is paramount regarding the admissibility of DNA evidence. Section 45 of the Evidence Act, 1872, pertains to expert testimony. The court's opinion on matters of foreign law, science, art, or handwriting (or fingerprint) identification is informed by the perspectives of individuals with specialized expertise in those areas, which are considered relevant facts. Individuals of this nature are referred to as experts.

In Kunhiraman v. Manoj<sup>6</sup>, This was the inaugural paternity case in India resolved via DNA

<sup>&</sup>lt;sup>5</sup> Section 293(2). Reports of certain Government scientific experts. (2) The Court may, if it thinks fit, summon and examine any such expert as to the subject- matter of his report.

<sup>&</sup>lt;sup>6</sup> 1991 (2) K.L.T. 190

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fingerprinting in the Court of the Chief Judicial Magistrate of Tellicherry. The Chief Judicial Magistrate determined that:

A man may refute the presumption of paternity imposed upon him by demonstrating that he had no access to the mother during the period of conception. Specifically, he must establish before the court that, due to significant physical distance or his impotence, there was no conceivable opportunity for him to engage in sexual intercourse with the mother at any time when conception could have occurred.196 If the husband cannot substantiate any of these claims, he shall be regarded as the child's father, even in the face of irrefutable scientific evidence to the contrary. In this context, the term 'access' signifies only the availability of the chance for marital intercourse.

Section 112 of the Indian Evidence Act, 1872 establishes a robust legal presumption of legitimacy that precludes scientific refutation. Numerous plaintiffs have, nonetheless, requested the court's leniency in admitting medical evidence to counter this significant legal presumption. These endeavors have produced a degree of success, and a consistent line of precedents from the early 1990s now substantiates the authority of courts to mandate medical evidence in circumstances they deem appropriate. In such instances, the court has often cited privacy rights as a significant factor to examine before to mandating an individual to undergo any testing.

In *Goutham Kundu v. State of West Bengal*<sup>7</sup>, the Supreme Court exhibited some reluctance in the utilization of DNA evidence to resolve the paternity question stemming from maintenance proceedings. In this instance, the father contested paternity and requested a blood grouping test to ascertain parentage in order to evaluate the child's entitlement to maintenance under section 125 of the Code of Criminal Procedure, 1973. The Supreme Court determined that if the sole intent of the maintenance application was to evade maintenance payments without presenting any valid justification for requesting a blood test, the application for the blood test could not be granted. It was determined that no individual may be coerced into providing a blood sample for examination against their will, and no negative inference may be made against them for such refusal.

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In a prominent case in 2010, Shri Rohit Shekhar v. Shri Narayan Dutt Tiwari, the Delhi High Court was tasked with ascertaining whether an individual possessed the right to compel the individual he identified as his biological father to undergo a DNA test.

In contrast to the trend observed in the preceding cases, it was the biological father who asserted his right to privacy in this instance. The Court invoked the United Nations Convention on the Rights of the Child (UNCRC) to uphold the child's right to be informed about their biological origins, regardless of their legality. The court determined that the paramount interest of the kid is to avoid being labeled illegitimate; nonetheless, the definitive nature of the legal presumption in this matter must not adversely affect the child's interests. If the child's best interests are served by establishing paternity of someone other than the mother's spouse, the court should not disregard that factor entirely.

## THE CONSTITUTIONAL LAW ON DNA IN INDIA

Article 51A of Part IV of the Constitution of India delineates the fundamental obligations. This Article stipulates that every citizen is required to fulfill specific responsibilities known as fundamental duties. Article 51A (h) and (j) stipulates that it is the fundamental duty of every citizen of India to cultivate scientific temper, humanism, and the spirit of inquiry and reform, as well as to aspire towards excellence in all domains of individual and collective activity, thereby ensuring the nation perpetually ascends to greater levels of endeavor and achievement. The term scientific temper refers to:

- i. The cognitive disposition underlying the approach to obtaining dependable and pragmatic knowledge.
- ii. The refusal to accept answers without empirical validation and experimentation.
- iii. The demand for robust information and irrefutable evidence, followed by appropriate analysis prior to acceptance.
- iv. The rejection of perspectives and opinions solely based on their traditional acceptance.
- v. The avoidance of obscurantist and superstitious practices.
- vi. The cultivation of intellectual openness and the absence of dogmatism.

## JUDICIAL ATTITUDE TOWARDS EVIDENTIARY VALUE OF DNA IN INDIA

The criminal inquiry begins when the police become aware of a crime's committed. The Code of Criminal Procedure, 1973 categorizes offenses into two classifications: cognizable offenses and non-cognizable offenses. Cognizable offenses typically include violent crimes such as murder, rape, and kidnapping, while non-cognizable offenses are generally less severe in nature. In instances of cognizable offenses, the police possess the authority to initiate investigations without a Magistrate's order, whereas in non-cognizable offenses, investigations commence only upon the Magistrate's directive. The police may apprehend an individual for a cognizable offense without a warrant, but are prohibited from doing so for non-cognizable offenses.

### Kunhiraman v. Manoj<sup>8</sup>

This was the inaugural case concerning the acceptance of DNA technology. The respondent Kunhiraman engaged in sexual intercourse with the petitioner's mother, Vilasini, under the pretense of a fraudulent promise of marriage. This culminated in her pregnancy. She delivered a child, Manoj. Subsequently, Kunhiraman refuted all allegations and altered his stance toward the marriage. She submitted a maintenance petition for his child pursuant to Section 125 of the Criminal Procedure Code, 1973, before the Chief Judicial Magistrate in Thalassery.

Due to the lack of a legal marriage between Vilasini and Kunhiraman, the Court had challenges in applying Section 112 of the Indian Evidence Act, 1872. Consequently, the Court determined that the legitimacy of the child Manoj could be substantiated solely by scientific evidence. The Court ordered DNA testing for Manoj, Kunhiraman, and Vilasini. The DNA analysis was performed by the Centre for Cellular and Molecular Biology (CCMB) in Hyderabad. The DNA test data reveals that Kunhiraman and Vilasini are the biological parents of Manoj.

<sup>&</sup>lt;sup>8</sup> 1991 (2) KLT 190, Also available at Dinkar, V. R, Justice in Genes (Evidential Facets of Forensic DNA Fingerprinting), Asia Law House, Hyderabad, 1st Edition 2008, P.166-167

## **Rape and Murder Cases**

The emergence of DNA technology facilitates the identification of suspects in rape and murder cases. In rape cases, biological samples obtained from the victim might serve as compelling circumstantial evidence to establish the guilt of the accused, alongside other factors. In certain instances, the victim may conceive. The sample obtained from the fetus can be analyzed in comparison to the sample acquired from the accused using DNA technology.

### State of Tamilnadu v. Nalini and Ors.<sup>9</sup>

This is well recognized as the Rajiv Gandhi assassination case. Rajiv Gandhi, a former Prime Minister of India, was assassinated by a suicide bomber. The primary perpetrator was killed, resulting in the destruction of most material evidence in the extensive explosion. Furthermore, the remains of both the victim and the perpetrator were mutilated beyond identification. DNA analyses facilitated the identification of severed body pieces belonging to both the victim and the perpetrator.

A conspiracy charge was filed against 41 individuals for violations of the Terrorist and Disruptive Activities (Prevention) Act, 1987 (TADA), Indian Penal Code (IPC), Explosive Substances Act, 1908, Arms Act, 1959, Passport Act, 1967, Foreigners Act, 1946, and the Indian Wireless Telegraphy Act, 1933; 12 of these individuals were deceased by suicide, and three were fugitives.

The prosecution interrogated 288 witnesses and presented various papers and physical evidence. All accused individuals' statements were documented pursuant to Section 313 of the Code of Criminal Procedure. They refuted their participation. The trial court adjudicated them guilty of the alleged offenses. The trial court sentenced twenty-six defendants to death. Displeased by the aforementioned judgment, all the defendants filed an appeal with the Supreme Court. The Supreme Court affirmed the convictions of all defendants and upheld the death sentences for four individuals, altering the penalties for the remaining defendants to life imprisonment and various periods.

<sup>&</sup>lt;sup>9</sup> 1991 SCC (3) 87

On February 18, 2014, the Supreme Court mitigated the death sentences of three defendants. The day following the Supreme Court ruling, the Tamil Nadu government mandated their release. The central government contested and pursued the Supreme Court. The Supreme Court prohibited the state government of Tamil Nadu from releasing three accused individuals.

In this instance, DNA evidence used as circumstantial evidence to associate the perpetrator with the crime and to identify both the victim and the accused. The subsequent chapter addresses DNA technology in the United Kingdom and the United States of America.

## HUMAN DNA PROFILING BILL 2012

In 2007, the Centre for DNA Fingerprinting and Diagnostics, an autonomous entity financed by the Department of Biotechnology within India's Ministry of Science and Technology, introduced the Draft DNA Profiling Bill.<sup>10</sup> The Draft DNA Profiling Bill was subsequently disclosed to the public. However, it exhibited numerous deficiencies and provoked significant opposition from NGOs and activists. Consequently, this Bill was never presented in Parliament. The Government instructed the Department of Biotechnology and the Centre for DNA Fingerprinting and Diagnostics (CDFD) in Hyderabad to revise the 2007 Bill.<sup>11</sup> In February 2012, the Department of Biotechnology drafted the Bill. It was subsequently circulated to various ministries for their comments and feedback.<sup>12</sup> An additional Working Draft of the Bill, titled Human DNA Profiling Bill 2012, was produced in April 2012. The Planning Commission of the Government of India appointed a panel of experts, chaired by Former Chief Justice A.P. Shah of the Delhi High Court, to evaluate the 2012 Bill concerning privacy.

### **DNA Laboratories**

All DNA laboratories must obtain approval from the board prior to performing any

http://mrunal.org/2013/01/polity-dna-profiling-bill-feature-application-criticism.html. [Accessed: 12-Jan-2025] <sup>12</sup> "Draft Human DNA Profiling Bill April 2012," [Online]. Available: <u>http://cis-india.org/internet-governance/blog/draft-human-dna-profiling-bill-april-2012</u>. [Accessed: 12-Jan-2025]

<sup>&</sup>lt;sup>10</sup> "DNA Profiling Bill," [Online]. Available: <u>http://cis-india.org/internet-governance/blog/privacy/dna-profiling-bill</u>. [Accessed: 12-Jan-2025]

<sup>&</sup>lt;sup>11</sup> "Polity: DNA Profiling Bill Features, Applications, Criticism," [Online]. Available:

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human DNA procedures. However, an exception exists whereby the DNA laboratory operational at the commencement of this Act may conduct human DNA procedures immediately without prior approval. Each DNA laboratory must submit an application to the board for approval. The DNA laboratory operational at the initiation of this Act must submit an application for approval within six months of its commencement. The DNA Profiling Board must conduct a thorough inspection of the DNA laboratory, documentation, and records prior to granting approval. But, the application for approval shall not be rejected unless the applicant has been given an opportunity of being heard. The Board can withdraw the approval granted to a DNA laboratory, if it fails to fulfill the conditions. Any DNA laboratory aggrieved by an order of non-approval may prefer an appeal to the Central Government or any other authority specified by the Central Government within a period of thirty days from the order of withdrawal. Every DNA laboratory which has been approved for performing DNA analysis shall,

- a) follow such standards for quality assurance for DNA testing as specified by the board,
- b) establish and maintain a documented quality system, and
- c) establish and maintain quality manual with details.

The Bill requires that every DNA laboratory should ensure adequate security to minimize contamination. Similarly, it requires that DNA labs should follow documented evidentiary control, validation process, and analytical procedure and use of such equipment suitable for methods employed as the regulations made by the board. Every DNA laboratory should possess proper infrastructure. It should also employ qualified technical personnel, appropriate security, and system for safety of personnel as the regulations made by the board.

## ETHICAL IMPLICATIONS

The incorporation of DNA evidence in forensic science presents substantial ethical considerations that require thorough scrutiny. The consequences largely address privacy concerns, informed consent mandates, the accuracy and reliability of DNA evidence, and the possibility for discrimination.

**1. Concerns Regarding Privacy:** The accumulation and retention of DNA data provide significant privacy concerns. Individuals may not completely understand the utilization or

dissemination of their genetic information, resulting in possible misuse or illegal access to sensitive data. This issue is exacerbated by the potential for associating innocent individuals with criminal acts using DNA databases, which can reinforce racial inequities and prejudices in law enforcement procedures.<sup>13</sup>

**2. Informed Consent:** Securing informed consent is crucial for acquiring DNA samples. Individuals must be thoroughly informed about the objectives of DNA collection, the associated dangers, and their rights about data access and deletion. The lack of explicit consent rules may result in ethical difficulties, especially when persons experience coercion to submit samples.<sup>14</sup>

**3. Precision and Dependability:** While DNA evidence is frequently considered highly reliable, it is not devoid of imperfections. Errors made by humans during sample collection, processing, and interpretation can lead to erroneous convictions or exonerations. The inconsistency in the interpretation of DNA evidence by various forensic specialists highlights the imperative for rigorous quality controls and uniform standards across laboratories.<sup>15</sup>

**4. Discrimination and Bias:** The possibility that DNA profiling may intensify pre-existing societal disparities is a significant issue. Specific demographic groups may be overrepresented in DNA databases as a result of targeted policing strategies, prompting ethical concerns regarding fairness and equity in the criminal justice system. Comprehensive legal frameworks are necessary to safeguard against discrimination and provide equitable treatment in the management of DNA data.<sup>16</sup>

In conclusion, although DNA evidence is essential in contemporary forensic research, its utilization must adhere to thorough ethical standards that emphasize individual rights and public confidence. Ongoing discourse among legal professionals, ethicists, and the forensic

<sup>15</sup> ISFG, "Ethical Implications of Forensic Genetic Databases," 2023. [Online]. Available: <u>https://www.isfg.org/files/2023\_FDAB\_First\_Report.pdf</u>. [Accessed: 20-Jan-2025]

<sup>&</sup>lt;sup>13</sup> J. H. Smith and M. Singh, "Forensic DNA Profiling: Legal and Ethical Considerations," *Journal of Scientific Research and Reports*, vol. 30, no. 5, pp. 141–144, 2024. [Online]. Available: <u>https://doi.org/10.9734/jsrr/2024/v30i51929</u>. [Accessed: 20-Jan-2025]

<sup>&</sup>lt;sup>14</sup> P. Tiwari, "Legal and Ethical Implications of DNA Fingerprinting," *Journal of Scientific Research and Reports*, vol. 30, no. 3, pp. 236–242, 2024. [Online]. Available: <u>https://doi.org/10.9734/jsrr/2024/v30i31875</u>. [Accessed: 20-Jan-2025]

<sup>&</sup>lt;sup>16</sup> D. H. Kaye, "The Ethical Implications of DNA Profiling for Resilience in a Globalized Context," *Emerald Insight*, 2007. [Online]. Available: <u>https://www.emerald.com/insight/content/doi/10.1108/978-1-83753-734-120241009/full/html</u>. [Accessed: 20-Jan-2025]

community is crucial for adeptly addressing these difficulties and guaranteeing the responsible application of developments in DNA technology.

## FUTURE DIRECTIONS FOR DNA TECHNOLOGY

The future of DNA technology in forensic science is set for substantial breakthroughs that will improve the accuracy, efficiency, and usefulness of DNA evidence in criminal investigations. As we progress, numerous critical trends and nascent technologies are expected to influence the domain of forensic DNA analysis, tackling existing issues while presenting new prospects for law enforcement and the judicial system.<sup>17</sup>

A significant advancement in forensic DNA technology is the utilization of **Next-Generation Sequencing (NGS)**, commonly referred to as **Massively Parallel Sequencing (MPS)**.<sup>18</sup> This method enables the concurrent sequencing of many DNA samples, markedly enhancing the throughput and sensitivity of genetic analysis. In contrast to conventional Short Tandem Repeat (STR) profiling, which often examines a restricted number of loci, Next-Generation Sequencing (NGS) can focus on a significantly broader array of genetic markers, encompassing Single Nucleotide Polymorphisms (SNPs) and mitochondrial DNA. This capacity boosts discrimination power and facilitates the analysis of degraded or low-quality samples that would be difficult to evaluate with conventional approaches. The capacity to derive extensive genetic data from small samples—such as touch DNA—creates new opportunities for resolving cold cases and identifying culprits in previously insolvable crimes.<sup>19</sup>

Alongside NGS, forensic genetic genealogy is developing as a revolutionary instrument in criminal investigations. This method employs publicly accessible DNA databases to ascertain possible relatives of suspects through common genetic markers. Law enforcement can utilize genetic data to develop family trees, thereby tracing links and refining suspect lists in intricate instances where conventional investigative techniques may be inadequate. The effective implementation of this technique in prominent cases has illustrated its capacity to resolve

<sup>&</sup>lt;sup>17</sup> National Institute of Justice (NIJ), "*DNA Initiative: Enhancing Criminal Justice with DNA Technology*," 2024. [Online]. Available: <u>https://nij.ojp.gov/topics/articles/dna-initiative-advancing-criminal-justice-through-dna-technology</u>. [Accessed: 21-Jan-2025]

<sup>&</sup>lt;sup>18</sup> J. Salerno and R.G. Smith, "Emerging Technologies in Forensic DNA Analysis," 2024. [Online]. Available: <u>https://papers.ssrn.com/sol3/papers.cfm?abstract\_id=4956325</u>. [Accessed: 21-Jan-2025]

<sup>&</sup>lt;sup>19</sup> D.R. Hares and J.P. McClure, "The Future of Forensic DNA Analysis," *Forensic Science Review*, vol. 32, no. 1, pp. 45-67, 2021.

enduring enigmas and provide closure to the families of victims. Nonetheless, it also prompts ethical considerations pertaining to privacy and consent, as individuals may remain unaware that their genetic information could be utilized in criminal investigations.<sup>20</sup>

A significant development is the incorporation of *Artificial Intelligence (AI)* into forensic DNA analysis. AI-driven solutions can aid forensic scientists in deciphering intricate DNA mixtures, automating data analysis, and enhancing result accuracy. Machine learning algorithms can be trained to identify patterns in extensive datasets, improving the capacity to differentiate between contributors in mixed samples—a prevalent issue in forensic cases. AI has the ability to enhance confidence in DNA evidence presented in court by minimizing human mistake and prejudice in interpretation. Nonetheless, meticulous attention must be devoted to guarantee the ethical application of these technologies and the explicit communication of their limitations to legal practitioners.<sup>21</sup>

The emergence of *rapid DNA analysis* signifies a notable advancement with tangible ramifications for law enforcement. This method permits on-site DNA testing within hours instead of days or weeks, hence expediting decision-making during investigations. Rapid DNA techniques are especially advantageous for analyzing samples from arrestees or crime scenes where prompt results are essential for guiding investigation actions. Nonetheless, the execution of quick DNA testing necessitates the establishment of stringent processes to guarantee precision and uphold chain-of-custody norms.<sup>22</sup>

As forensic science advances, *nanotechnology* is increasingly recognized for its potential to improve sensitivity in DNA analysis. Nanotechnology enhances the ability of scientists to examine evidence at the nanoscale, hence improving the detection of trace biological materials that could otherwise remain undetected. This may result in advancements in situations where just scant proof exists.

Notwithstanding these breakthroughs, other obstacles persist that must be resolved as we

<sup>&</sup>lt;sup>20</sup> Sorenson Forensics, "*The Future of Forensic DNA Analysis and Its Impact on Law Enforcement*," 2024. [Online]. Available: <u>https://sorensonforensics.com/the-future-of-forensic-dna-analysis-and-its-impact-on-law-enforcement</u>. [Accessed: 21-Jan-2025]

 <sup>&</sup>lt;sup>21</sup> National Center for Biotechnology Information (NCBI), "Advancements in Forensic DNA Analysis," 2021.
[Online]. Available: <u>https://pmc.ncbi.nlm.nih.gov/articles/PMC8457771/</u>. [Accessed: 21-Jan-2025]
<sup>22</sup> PMC, "*Future Directions of Forensic DNA Databases*," 2014. [Online]. Available:

https://pmc.ncbi.nlm.nih.gov/articles/PMC4009716/. [Accessed: 21-Jan-2025]

progress with DNA technology in forensic research. Concerns with *data security*, *privacy*, and *ethical implications* are critical when increasingly advanced technology are incorporated into law enforcement methodologies. The proliferation of DNA databases engenders apprehensions regarding illicit access and the possible exploitation of sensitive genetic data. Policymakers must formulate explicit regulations for the storage and use of DNA data to safeguard individual rights while enabling law enforcement authorities to utilize these potent tools efficiently.<sup>23</sup>

Furthermore, there is an urgent requirement for continuous education and training for forensic specialists about the interpretation of intricate DNA profiles generated by new technologies such as NGS and AI-driven systems. It is imperative that practitioners are proficient in these approaches to protect the integrity of forensic evidence presented in court.

In summary, the prospective advancements in DNA technology for forensic science present significant potential for augmenting investigative efficacy and optimizing results within the criminal justice system. As technologies like NGS, forensic genetic genealogy, AI integration, quick DNA analysis, and nanotechnology progress, it is imperative that ethical considerations direct their application. Achieving equilibrium between innovation and the safeguarding of privacy rights is essential for ensuring that these technologies fulfill their intended objective: administering justice while preserving individual freedoms.

## **CONCLUSION**

DNA technique was developed by Sir Alec Jeffreys at the University of Leicester in 1985. Initially, DNA technology was employed for scientific study. It is now utilized for identification purposes. DNA technology is utilized not only to identify the actual perpetrator but also to exonerate the innocent suspect from legal repercussions. DNA, or Deoxyribonucleic acid, serves as the genetic blueprint for humans. The DNA of human beings remains unchanged throughout their existence. However, it differs among individuals, excluding genetically identical twins. The distinctiveness of DNA renders it an efficient investigation instrument for identifying the true perpetrator via the investigating apparatus. DNA can be extracted from blood, semen, hair, fingernail clippings, teeth, body tissues, bones, saliva, urine, fetal material,

<sup>&</sup>lt;sup>23</sup> LIFS, "*The Future of Forensic Science: Emerging Technologies and Trends*," 2024. [Online]. Available: <u>https://lifs.co.in/blog/forensic-science-emerging-technologies-trends.html</u>. [Accessed: 21-Jan-2025]

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post-mortem samples, and other bodily fluids. It may also be potentially identified from the weapon's grip, bite marks, cigarette butts, glass, etc. The gathered samples will be appropriately stored, packaged, sealed, and transferred to the forensic laboratory. This is a crucial step for effective DNA analysis. The forensic scientist will do DNA analysis on material submitted to the laboratory by the investigation authorities. The forensic experts do not examine the complete genome; rather, they investigate specific loci on the DNA molecule. In the early 1900s, prior to the emergence of DNA technology, three methods for paternity detection were employed: Blood Typing, Serological Testing, and Human Leukocyte Antigen (HLA) testing. These strategies were inadequate and exceedingly challenging to execute. Subsequent to the emergence of DNA technology, five methodologies were established.

As of currently, India lacks clear regulation governing the gathering of biological samples for DNA analysis. Sections 53, 54, 53A, 164A, 173(8), 293(2) & (4) of the Criminal Procedure Code, 1973, Sections 45 and 112 of the Indian Evidence Act, and Section 27 of the Prevention of Terrorism Act, 2002 pertain to DNA testing. Despite the formal acknowledgment of DNA testing under the aforementioned regulations, disagreements frequently emerge over the authorities delineated in Section 53 of the Criminal Procedure Code, 1973, as well as the constitutional legitimacy of that section.

The Supreme Court and different High Courts have determined that the collection of biological samples from the accused for DNA analysis pursuant to Section 53 of the Criminal Procedure Code, 1973, does not encounter constitutional obstacles under Article 21 and Article 20(3) of the Indian Constitution. The framers of the constitution do not assert that no individual shall be stripped of their rights or personal liberty under any circumstances.<sup>24</sup> Conversely, if the denial of rights or personal liberty adheres to the procedure prescribed by law, it does not contravene Article 21 of the Indian Constitution. If the physical inspection of the skin and body is permitted without the inclusion of a blood sample for blood type determination, the fundamental objective of Section 53 of the Criminal Procedure Code will be undermined.545 A specimen of handwriting, signature, or fingerprint alone provides no evidence, as they are entirely harmless and immutable, unless in rare instances where the finger ridges or writing style have been altered.

<sup>&</sup>lt;sup>24</sup> H. M. Prakash Alis Dali v. State of Karnataka, 2004 (3) KarLJ 584

They serve solely as comparative materials to provide the court with confidence that its conclusions drawn from other evidence are dependable. They are neither oral nor documented evidence but fall into the third category of material evidence, which is beyond the scope of testimony. The framers of the constitution should not have aimed to impede efficient and effective criminal investigations and the prosecution of offenders.<sup>25</sup> Therefore, the collection and preservation of DNA samples, which constitute tangible evidence, do not encounter constitutional obstacles within the Indian framework.<sup>26</sup>

## **SUGGESTIONS**

Section 53 of the Criminal Procedure Code, 1973 requires amendment.<sup>27</sup> The revised Section 53 of the Criminal Procedure Code, 1973 should be as follows:

Section 53 of the Criminal Procedure Code, 1973: Assessment of the accused by a medical professional at the behest of a police officer or court adjudicating the offense.

(1) When an individual is arrested or released on bail, or if arrested on a charge of committing an offense under circumstances that provide reasonable grounds to believe that an examination of their person may yield evidence of the offense, it is lawful for a registered medical practitioner, upon the request of a police officer of at least sub-inspector rank or a court adjudicating the offense, and for any individual acting in good faith under their direction, to conduct a reasonable examination of the arrested person to ascertain facts that may provide such evidence, employing such force as is reasonably necessary for that purpose.

(2) Section 173(8) of the Criminal Procedure Code, 1973 requires amendment.565 The revised Section 173(8) of the Criminal Procedure Code, 1973 should be articulated as follows:

<sup>26</sup> Smt Selvi and Others v. State of Karnataka, (2010) 7 SCC 263

<sup>27</sup> Section 53 of the Criminal Procedure Code, 1973:

<sup>&</sup>lt;sup>25</sup> State of Bombay v. Kathikalu Oghud, AIR 1961 SC 1808; H. M. Prakash Alis Dali v. State of Karnataka, 2004 (3) KarLJ 584; Thongorani Alias K. Damayanti v. State of Orissa and Ors, 2004 CriLJ 4003

Examination of Accused by Medical Practitioner at Police Officer's Request (1) When an individual is apprehended on suspicion of committing an offense under circumstances that provide reasonable grounds for believing that an examination of their person will yield evidence regarding the commission of the offense, it is permissible for a registered medical practitioner, acting upon the request of a police officer of at least sub-inspector rank, and for any individual assisting in good faith under their direction, to conduct a reasonable examination of the arrested individual to ascertain facts that may provide such evidence, employing such force as is reasonably necessary for that purpose.

**Section 173(8) of the Criminal Procedure Code, 1973 -** (8) This section does not prohibit additional investigations, including medical examinations of the accused and the victim, concerning an offense after a report under sub-section (2) has been submitted to the Magistrate. If, during such investigations, the officer in charge of the police station acquires further evidence, whether oral or documentary, he must submit a supplementary report or reports to the Magistrate in the prescribed format. The provisions of sub-sections (2) to (6) shall apply to these supplementary reports as they do to the report submitted under sub-section (2).

(3) Section 112 requires amendment.566 The aggrieved party, whether husband, wife, or child, must be afforded a proper opportunity to contest the presumption established under Section 112 of the Indian Evidence Act, 1872, through a DNA test. The revised Section 112 of the Indian Evidence Act, 1872 should be as follows:

Section 112 of the Indian Evidence Act, 1872 - Birth within marriage as definitive evidence of legitimacy: Any individual born during the validity of a marriage between his mother and a man, or within two hundred and eighty days following its dissolution while the mother remains unmarried, shall be deemed the legitimate offspring of that man, unless evidence is presented demonstrating that the spouses had no access to one another during the period in which conception could have occurred.

# Evidence of non-access between the husband and wife can be established with a DNA test.

(4) Advanced technologies such as Laboratory Information Management Systems (LIMS), familial searching, and Low Copy Number (LCN) DNA testing can be implemented from the United Kingdom. Postconviction DNA testing can be used from the United States of America.

(5) Currently, in comparison to the United Kingdom and the United States, India is densely populated and experiences a deficiency in laboratory facilities, staffing, and money. It is essential to adhere to the direction of other nations that have effectively implemented DNA legislation, particularly the United Kingdom and the United States of America.

(6) Legislation pertaining to DNA should be established. The subsequent provisions ought to be included in such legislation.

- i. Protocols for the collection of biological specimens;
- ii. Protocols for the preservation of biological specimens prior to DNA analysis;
- iii. Sufficient laboratory facilities;
- iv. Standards and quality of the forensic laboratory;
- v. Adequate staffing resources;
- vi. Tests performed by the forensic laboratory;
- vii. Financial resources.
- viii. Appropriate venue to assess whether the accepted DNA test was performed by forensic laboratories.
  - ix. Compliance with the National Privacy Principles suggested by the Expert Committee chaired by A. P. Shah, the former Chief Justice of the Delhi High Court, in 2012.